MWaDi: Mars CubeSat Mission Concept

Mars Water Distribution Mission

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MWaDi Mars Science Objectives

MEPAG Goal	MWaDi Multi-platform Distributed Measurements	Mission Requirement
Water and other Volatile Exchange on all scales	H2O, CO2 forms, components, frost, clouds	Simultaneously obtained spatially Distributed inter- and intra-Seasonal and Global Event Variations
Geology processes and evolution, Variation in Composition of Surface, Dust Distribution	Silicate Minerals, sulfides, carbonates, oxides, hydrates	Spatial and Seasonal Variations for same locales on a relatively frequent basis

MWaDi Payload

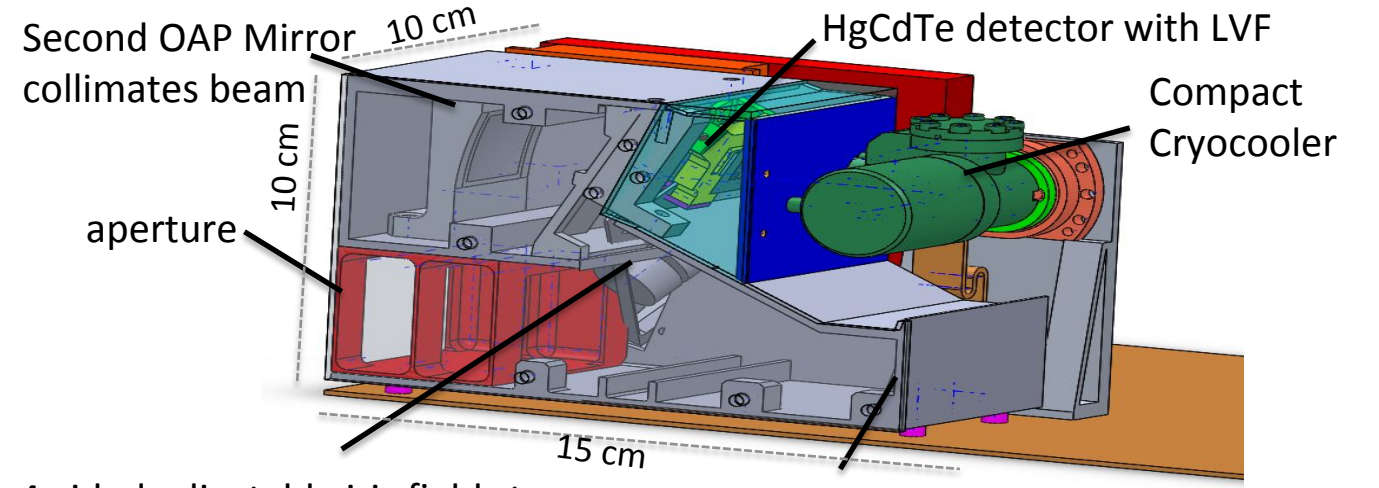
Robust (for target environment) spectrometer w/ compact microcryocooler, optics

Broadband and sufficient spectral resolution (5 nm) to characterize and distinguish important volatiles (water, H_2S, NH_3, CO_2, CH_4, OH) and mineral (silicate, oxides, carbonates, hydrates) bands

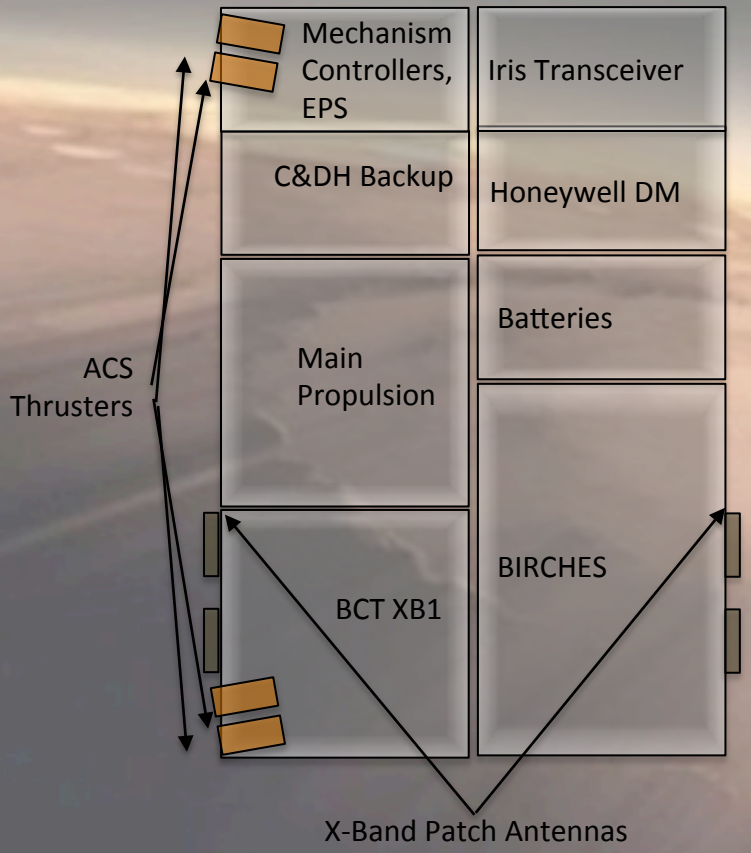
Flexibility in maintaining spot size (10 x 10 km +/- 10% area) regardless of variations in altitude or in using variable spot size at given altitude as application requires

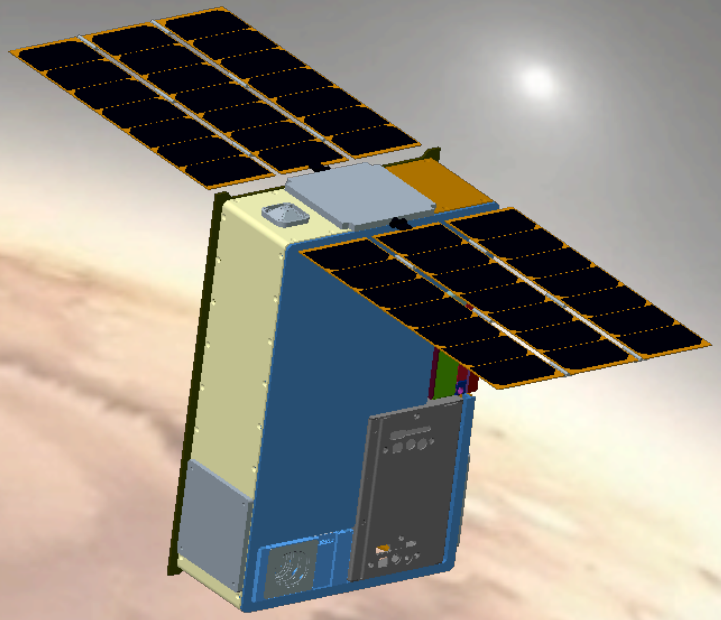
Generic Adaptability of optics and electronics (for point spectrometer or imager modes) depending on available bandwidth

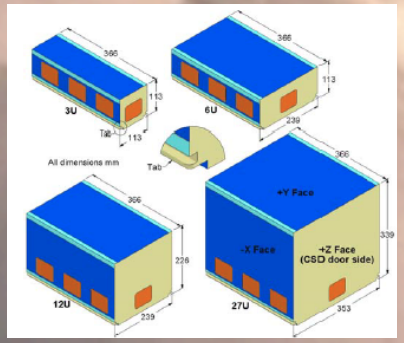
BIRCHES:
1.5U
<2.5 kg
<5 W



MWaDi Concept based on LWaDi lunar 6U orbiter to determine lunar water distribution as function of time of day, latitude, regolith composition, age







Thermal Modeling for LWaDi for robust 'over design' for Mars environment

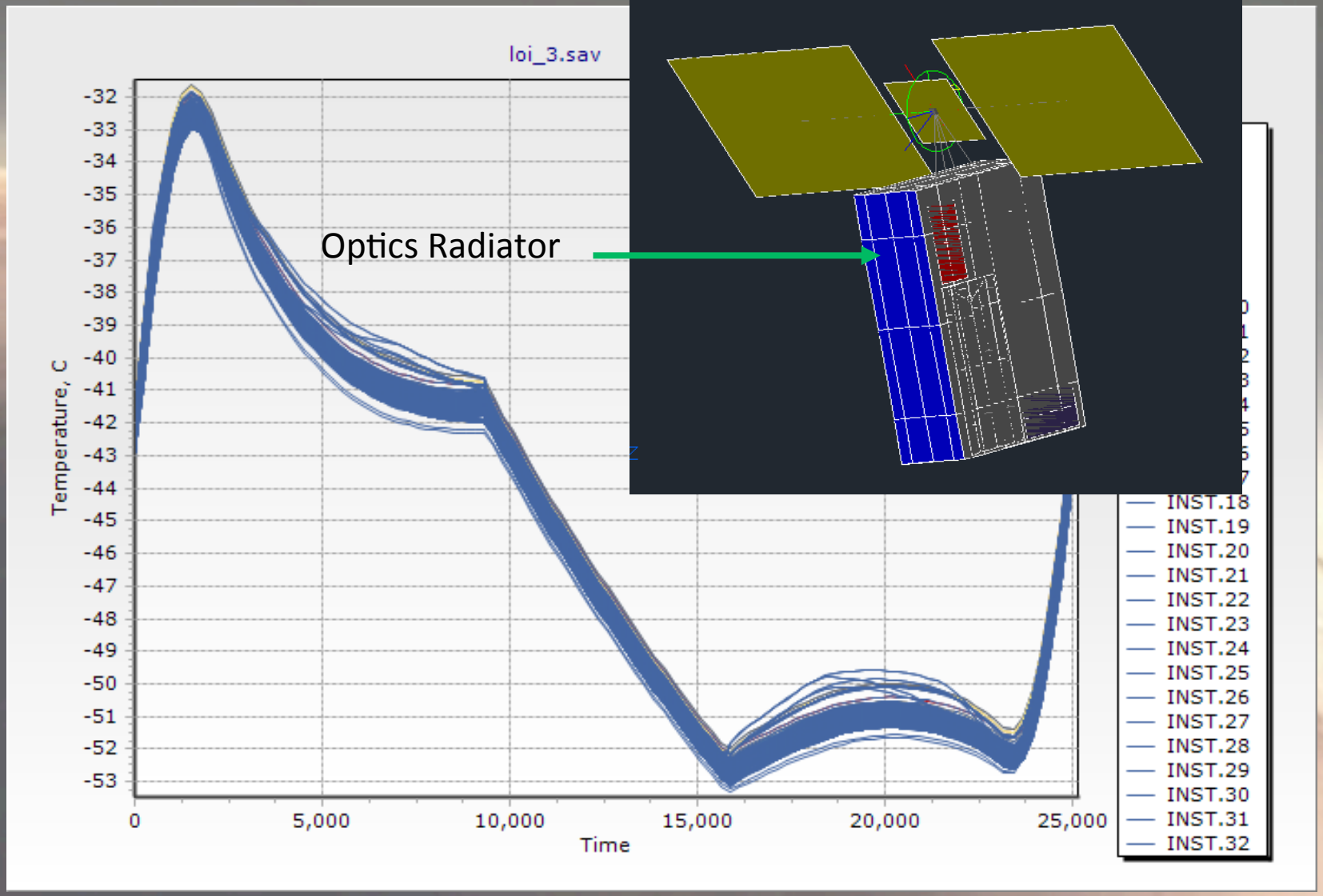


Table 2 Deep Space/Resource Allocations					
System	Description	Heritage	Mass kg	Volume U	W (peak)
ACS/Propulsion	Star tracker, sun sensor, Momentum Wheels, propulsion (p)	BCT XB1 (RWA, sun sensor, star trackers), GWU ucat or MIT PETA main and ACS thrusters	1.5	1.5	10 p ACS 60 p transit
C&DH/ Processing	Science and engineering management, processing	BCT XB1 (C&DH), Honeywell DM, backup	1.5	1.5	5
Structures/ Mechanisms	Frame, deployer, deployables (Gimballed, stowable Solar panel array, antennas)	PSC 6U deployer, MMA Design Ehawk gimballed solar panels	4		70 (provide)
Mechanism Controllers	For solar panels, thrusters		0.5	0.5	10
Comm	Antenna, transceiver	INSPIRE IRIS Dual X-band patch antennas, transceiver	0.5	0.5	10
Power	Electrical system, conversion, regulation, batteries	GOM batteries, EPS	1.	0.5	
Instrument and thermal	Detector, optics, associated electronics, cryocooling; Passive Shielding, Passive cooling	Teledyne 1-4u HgCdTe, tactical cryocooler; thermal in house	1.5	1.5	5
Total			10.5	6.	

MarsCube Challenges

Mobility/Transportation: Assuming delivery MWaDi platforms via carrier or as a secondary payload to Mars 'mapping orbits' (roughly circular, hundred(s) of km). Achievement and maintenance of desirable orbit, pointing needed for communication or imaging require a compact capable attitude control system (star trackers, IMU, momentum wheels, microthrusters).

Solution: Current high-end ACS systems (BCT XB1) and next generation compact micropropulsion systems under development, and capable of providing high precision maneuvering and attitude control once at the final destination.

Thermal/Mechanical, C&DH: Deep space thermal and radiation protection with associated mass and volume penalties. Months to years operation instead of days to months for CubeSat.

Solution: Overdesign for thermal 'worst case scenario (Moon), high cumulative dose tolerant and radiation hard by design electronics.

Power Generation : many 10's watts power and energy storage during eclipse**.**

Solution: Next generation solar panels generating 10's of Watts, special packaging of batteries.

Communication: communication without supporting infrastructure available for terrestrial UHF.

Solution: In short run, focused data-taking, minimal navigation and tracking to minimize downlink bandwidth. In long run, infrastructure of existing landed assets, carrier to allow local (UHF?) data transmission and navigation. Also, use of onboard autonomous optical navigation.

Autonomy: Need for far more internal control, adaptable and stable operation, and 'smartness' for proliferating small systems.

Solution: Frontier Synthetic Neural System enabled Intelligent Decision Engine capable of learning and adapting in response to user demand and environmental changes